# Linking Soil Nitrogen & Carbon to Post-Wildfire Water Quality

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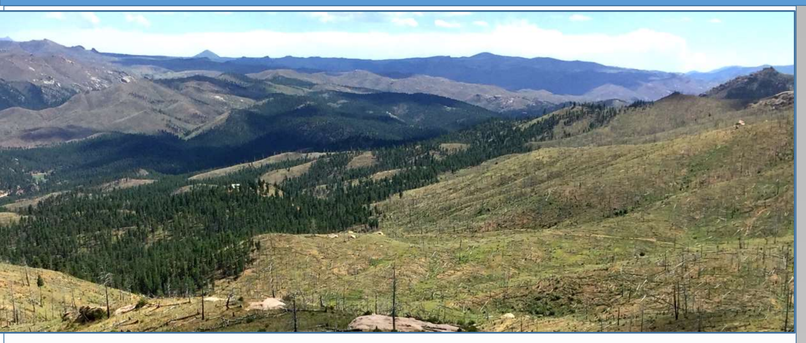
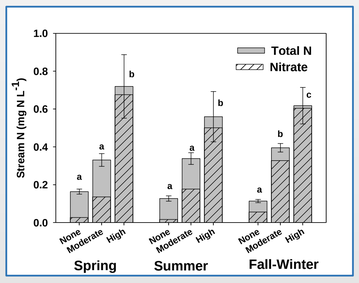


## BACKGROUND

Forest fires create lasting biogeochemical changes with implications for watershed processes and stream water quality. Decreased plant nutrient uptake and increased mineralization of soil organic matter are the mechanisms commonly held responsible for persistent changes. Our work after the 2002 Hayman Fire shows that increased stream nitrogen (N) is proportional to the extent of a catchment burned by high severity wildfire, but the specific processes responsible for the patterns are uncertain.



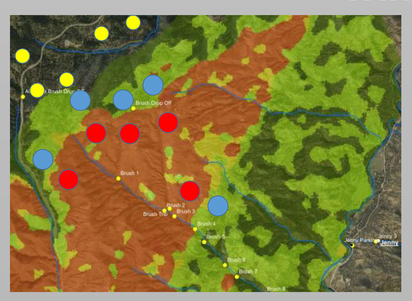

14 years after the Fire, nitrate levels in catchments with extensive high severity wildfire are 5-12 times above unburned streams (0.02 mg $L^{-1}$); well above EPA ecoregion reference streams (0.01 mg $NO_3$-N $L^{-1}$).

Heating organic soil layers creates char layers that can persist for many years. Temperature and rate of fire spread vary for moderate and high severity wildfire and may influence char layer composition.

## OBJECTIVES

To elucidate factors that regulate persistent elevated stream N, as well as post-fire stream carbon (C) export, we examined soil N and C pools and processes across ecotones extending from unburned forests to areas of moderate and high wildfire severity. We analyzed 1-2 cm thick charred organic layers that remain visible 14 years after the fire, underlying mineral soils, and leachate from both layers.

### Wildfire Burn Severity

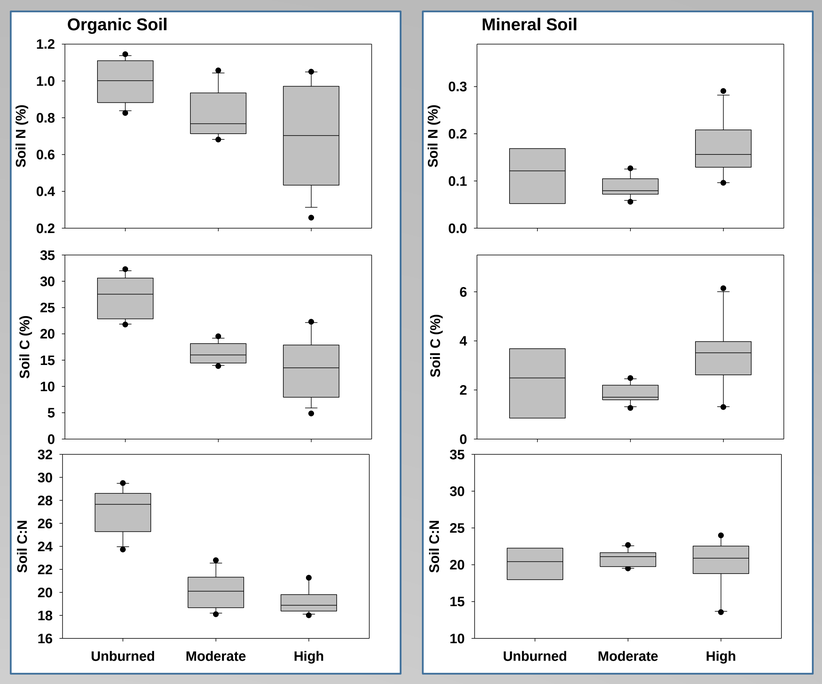


***High Severity*** All/nearly all pre-fire ground cover, surface OM consumed.

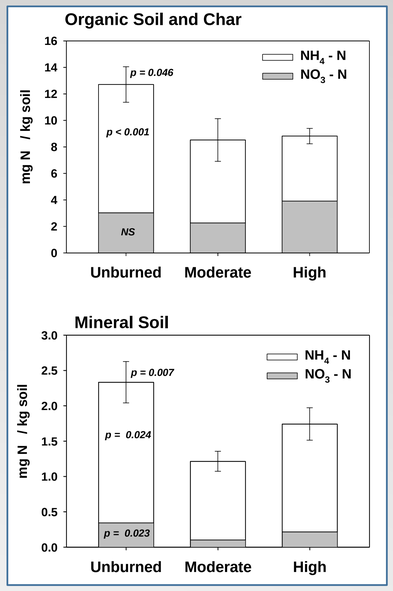
***Moderate Severity*** Most (≤80%) ground cover, OM consumed. Foliage may remain in tree canopies.

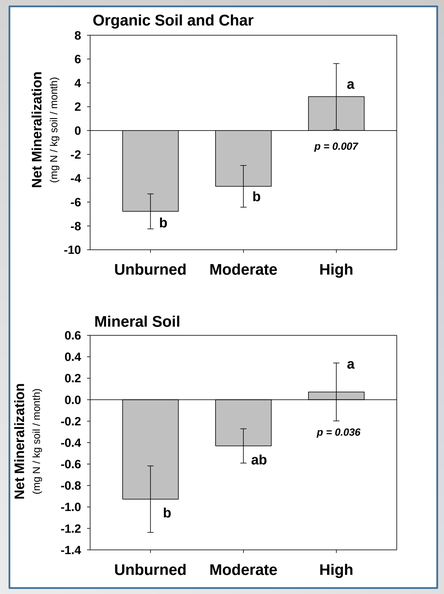
We sampled high & moderate severity sites and areas outside the burn with similar pre-fire forest & soils (n = 5).

## CHAR PROPERTIES




C and N concentrations in organic soil layers of unburned forests were higher than char layers sampled across burn severity ecotones. Mineral soil (0-5 cm depth) beneath char layers in high severity portions of the Hayman Fire had significantly more soil N and C and lower pH.




Extractable soil ammonium, total plant available N and gravimetric moisture (not shown) were all significantly higher in unburned organic and mineral soils than in char layers of burned mineral soils. Extractable nitrate was also higher for unburned mineral soils.

Potential net mineralization – an index of the supply of plant-available nitrogen – differed between the severely burned areas and the unburned and moderate burn areas. Negative net mineralization indicates consumption or immobilization of the inorganic N produced in unburned and moderately burned soils. In contrast, soils burned at high burn severity produced inorganic N available for plants or leachate or gas losses. Ammonium represented 90% of the inorganic N supply and net nitrification differed little between burn severity levels.

### SOIL DESCRIPTION & ANALYSIS METHODS

Sandy-skeletal, shallow Typic Ustorthent
Weathered from Pikes Peak granite

***Char and Mineral soils***
Total, Extractable N and Net N mineralization

***Leachate Chemistry***
IC, DOC, TDN….
Optical Properties: SUVA…..
Black Carbon - pyroC
DBP – precursors..

## CHAR LEACHATE

| | Organic Soil | | | | | Mineral Soil | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unburned | Moderate | High | *p* = | | Unburned | Moderate | High | *p* = |
| DOC | 43.36 | 24.26 | 19.47 | < 0.001 | DOC | 10.20 | 7.70 | 6.93 | 0.001 |
| TDN | 8.91 | 4.78 | 4.88 | 0.017 | TDN | 1.84 | 1.74 | 1.87 | NS |
| DON | 7.88 | 4.01 | 4.10 | 0.006 | DON | 1.78 | 1.67 | 1.69 | NS |
| $NO_3$-N | 0.33 | 0.35 | 0.46 | NS | $NO_3$-N | 0.03 | 0.05 | 0.13 | < 0.1 |
| $NH_4$-N | 0.70 | 0.42 | 0.31 | < 0.1 | $NH_4$-N | 0.03 | 0.03 | 0.06 | NS |
| DIN | 1.03 | 0.77 | 0.77 | NS | DIN | 0.06 | 0.07 | 0.18 | < 0.1 |
| $NO_3$-N:DIN | 0.32 | 0.41 | 0.56 | < 0.1 | $NO_3$-N:DIN | 0.50 | 0.59 | 0.65 | NS |
| DON:DOC | 0.18 | 0.16 | 0.21 | NS | DON:DOC | 0.17 | 0.22 | 0.24 | 0.05 |
| TDN:DOC | 0.21 | 0.20 | 0.25 | NS | TDN:DOC | 0.18 | 0.23 | 0.27 | 0.008 |
| pH | 6.14 | 7.36 | 7.20 | < 0.001 | pH | 6.16 | 6.94 | 6.47 | NS |
| ANC | 259.14 | 676.87 | 898.85 | 0.007 | ANC | 61.22 | 362.89 | 129.11 | NS |

Leachate DOC was higher in unburned soils for both organic and mineral layers. TDN, DON and NH4-N were higher in unburned soils for the organic layer only.

Nitrate comprised a larger proportion of DIN leaching from the organic soil for high burn severity sites.

For severely-burned mineral soils there was higher nitrate and DIN, as well as more DON and TDN per unit of DOC in leachate.

## KEY FINDINGS

The N and C characteristics of soils inside the Hayman burn perimeter remained different from unburned soils 14 years after the fire.

Burn severity had some effect ….
The total N pool size and supply of inorganic N was higher in areas burned at high severity.

More N leached per unit C in severly burned areas. Nitrate comprises a greater portion of the DIN leached from severely burned soils.

### IMPLICATIONS FOR WATERSHED RECOVERY

Implications for site C inventory..??

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